AQA Chemistry A-Level

3.1.2: Amount of Substance

Detailed Notes

3.1.2.1 - Mr and Ar

Relative atomic mass (**Ar**) is defined as:

The mean mass of an atom of an element, divided by one twelfth of the mean mass of an atom of the carbon-12 isotope.

Relative molecular mass (**Mr**) is defined as:

The mean mass of a molecule of a compound, divided by one twelfth of the mean mass of an atom of the carbon-12 isotope.

For ionic compounds, is it known as **relative formula mass**.

3.1.2.2 - Moles and the Avogadro Constant

The mole is a **unit of measurement** for substances. It always contains the **same number of particles**.

$$L = 6.022 \times 10^{23} \text{ particles}$$

This number is the **Avogadro Constant** (L) and allows the number of particles present in a sample of a substance with known mass to be found:

$$\text{Number of particles} = nL$$

(n = moles) (L = Avogadro constant)

The mole is a **very important unit of measurement** in many calculations:

$$\text{Moles} = \frac{\text{mass}}{\text{Mr}} = \frac{\text{concentration} \times \text{volume}}{1000}$$

(where concentration is in $moldm^{-3}$)

3.1.2.3 - Ideal Gas Equation

When under **standard conditions**, gases and volatile liquids follow certain trends:

pressure is proportional to temperature
volume is proportional to temperature
pressure and volume are inversely proportional

These relationships can be combined to give the **ideal gas equation**:

$$pV = nRT = \frac{mRT}{Mr}$$

In order to use this equation, the variables must be in the correct **standard units**:

p = pressure in Pascals
V = volume in m^3
T = temperature in Kelvin
n = moles
m = mass in grams

R is the **ideal gas constant**, equal to **8.31 $JK^{-1}mol^{-1}$**.

3.1.2.4 - Empirical and Molecular Formula

Empirical formula is the **simplest whole number ratio** of atoms of each element in a compound. It is found using **molar ratios** of each element.
(see model answer)

Molecular formula is the **true number of each atom in the molecule**. It can be determined using the **Mr of the empirical formula** and the **true Mr** of the molecule. This give a **multiplier** value which can be used to scale up the empirical formula.

$$\frac{\text{Mr of molecule}}{\text{empirical Mr}} = \text{multiplier}$$

(see model answer)

3.1.2.5 - Equations and Calculations

Chemical equations must be **balanced** before they can be used in calculations. This is because the **reacting ratios** must be correct.
It can then be used to calculate reacting masses, percentage yield and atom economy.

Percentage Yield

$$\% \text{ yield} = \frac{\text{Experimental mass} \times 100}{\text{Theoretical mass}}$$

Atom Economy

$$\% \text{ atom economy} = \frac{\text{Mr of desired product} \times 100}{\text{Mr of reactants}}$$

In industrial chemical processes it is desirable to have a **high atom economy** for a reaction. This means there is **little or no waste product**, only the desired product. Therefore it means the process is more **economically viable** for industrial scale manufacture.